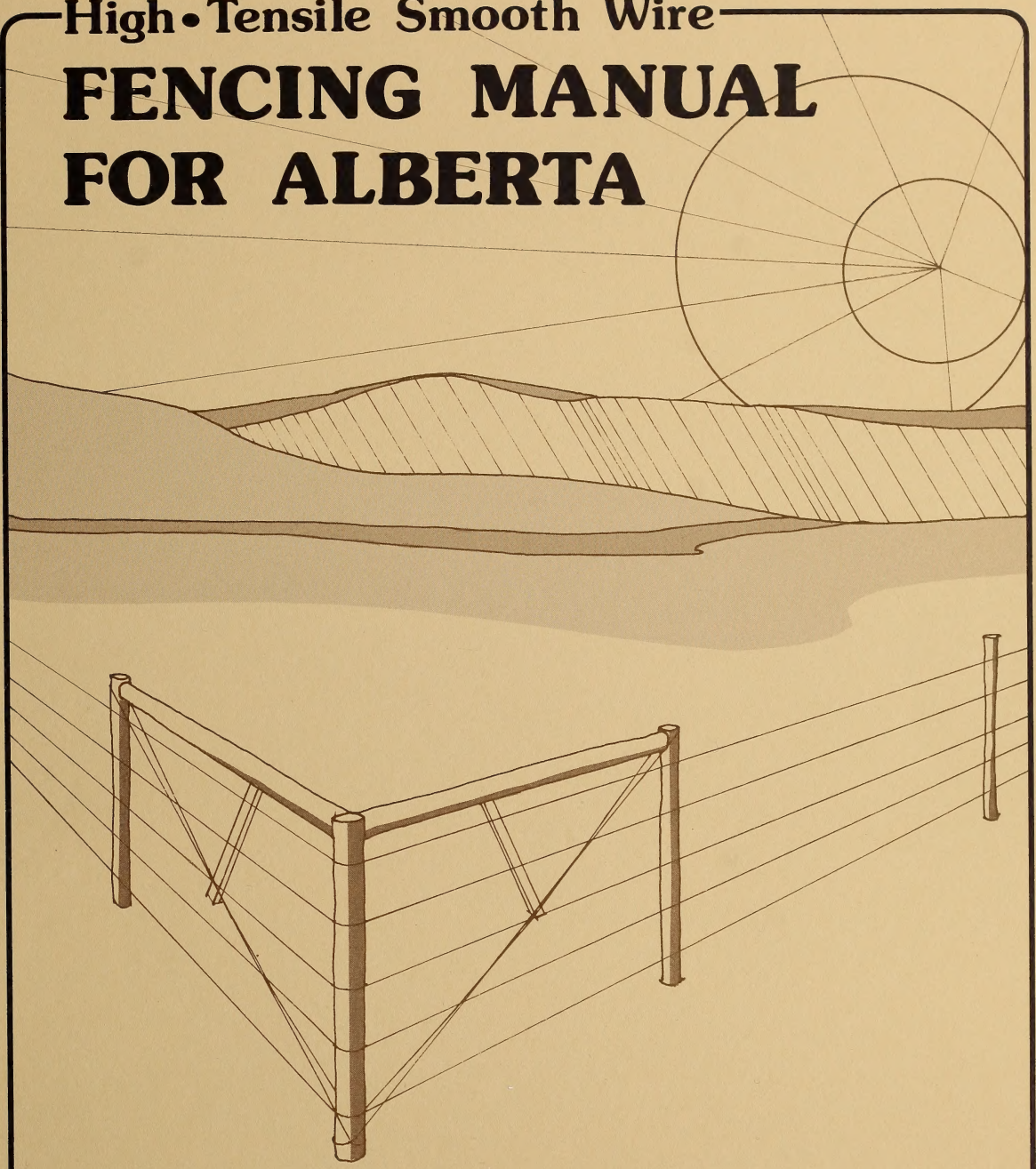
High • Tensile Smooth Wire

FENCING MANUAL FOR ALBERTA



Alberta
AGRICULTURE
AGDEX 724-3

Copies of this publication may be obtained from:

Print Media Branch
Alberta Agriculture
7000 – 113 Street
Edmonton, Alberta, T6H 5T6
OR
Alberta Agriculture's district offices

04 1985 3M

HIGH-TENSILE SMOOTH WIRE FENCING MANUAL FOR ALBERTA

Prepared by:
C.Drolet, Engineering Assistant
B.Kennedy, Regional Agricultural Engineer
M.Doggart, Regional Forage Specialist

Artwork by:
J. Stampe, Engineering Technologist
L. Wasylik, Agricultural Technologist

Photos by: M. J. Doggart

Agdex No. 724-3

Alberta
AGRICULTURE
ENGINEERING

TABLE OF CONTENTS

PART I INTRODUCTION

"Good fences make good neighbours."[1]. Fences provide protection for crops, control over breeding, protection of livestock, and are a good pasture management tool.

Fence design and development have not changed since barbed wire was patented in 1874 in the United States. A new type of fencing called "high-tensile smooth wire fencing" is presently gaining popularity. High-tensile smooth wire fencing has been in use in New Zealand and Australia for more than two decades and is presently being used in North America.

This fencing system makes use of multiple strands of smooth, 12.5 gauge, high-tensile galvanized steel wire. Each strand, when strung and stretched to the recommended 1.10 - 1.30 kN (250 -300 lb) of tension, withstands up to 6.70 kN (1500 lb) of livestock pressure and low temperature contraction without breaking.

High-tensile wire fences are versatile; they can be used in practically any fencing situation. By modifying the number and the space between strands, the fence can be used to contain horses, sheep, cattle and hogs. Special designs are used to provide protection from predators and wildlife.

Ideally a fence should have a low capital cost, be easy to install, have a long lifespan and be stockproof. High-tensile smooth wire fencing is such a system. The advantages of this type of fencing over conventional barbed wire fencing are:

1. **Cost:** High-tensile smooth wire is about half the cost of barbed wire per unit of length.

2. **Elasticity:** There are no barbs to catch on posts or staples, so the wire behaves elastically along its complete length. Impact at one point is redistributed to the brace assemblies at either end.

3. **Ease Of Handling:** The absence of barbs makes the wire easier to handle and effectively reduces construction costs.

4. **Safety:** Smooth wire has no barbs, reducing injury to livestock, particularly horses.

5. **Stretching:** High-tensile wire is prestretched and requires no additional stretching.

Figure 1. Typical range application of high-tensile smooth wire fencing.

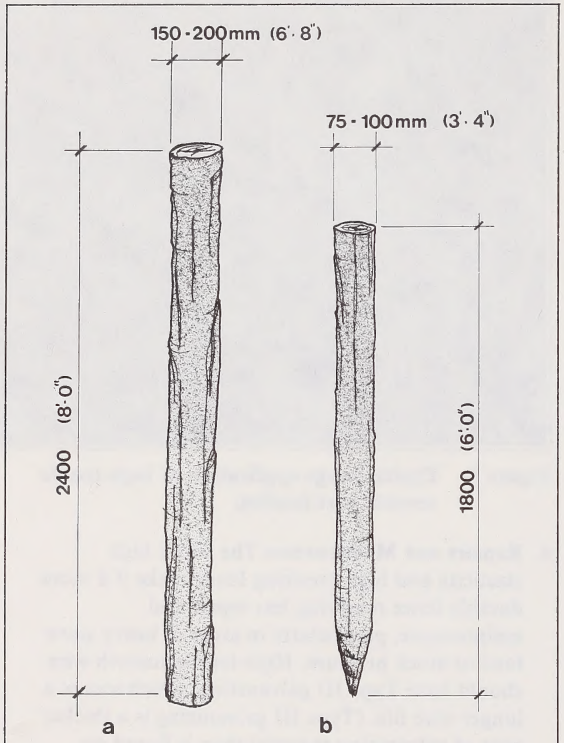
6. **Repairs and Maintenance:** The wire's high elasticity and high breaking loads make it a more durable fence requiring less repair and maintenance, particularly in areas of heavy snow load or stock pressure. High-tensile smooth wire should have Type III galvanizing, which means a longer wire life. (Type III galvanizing is a thicker coat of galvanizing material than is found on standard wire.)

   However, special tools, materials and techniques are needed to properly construct high-tensile smooth wire fences.

[1] *Robert Frost, MENDING WALL, 1914*

■ Posts

Wood is a suitable material for fence posts and braces. The life expectancy of high-tensile smooth wire fencing constructed with pressure treated posts and braces is over 30 years. Round wood posts are used so there are no sharp corners to kink wires or to injure livestock. Posts 150-200 mm (6-8 in.) in diameter are used to provide strength at ends, corners, braces and gates.



a) 150 - 200 mm post for end brace assemblies
b) picket used to support and space wires

Figure 2. Pressure treated fence posts

■ Wire

Wire used for high-tensile smooth wire fences is commonly 12.5 gauge high-tensile smooth wire, though other gauges are available from several manufacturers.

■ Fasteners and Hardware

Staples: Use 50 mm (2.0 in.) long staples, with slash cut points. The staples are not driven all the way home in the posts, so that the wire can slide through them.

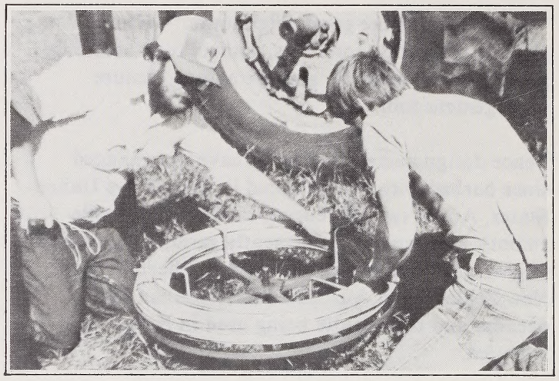


Figure 3. Coil of high-tensile smooth wire on a spinning jenny.

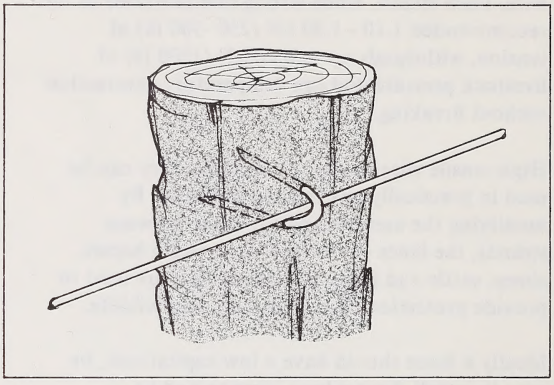


Figure 4. Staple. Note the space so that the wire can slide through the staple.

Metal dowels: Dowels should be used for constructing end, corner, gate and in line brace assemblies. Either 10M rebar or 10 mm steel rods, cut to length, can be used. For maximum dowel life, dowels should be galvanized. One 225 mm (9 in.) long and one 100 mm (4 in.) long will be needed for each single-span brace. Braces using dowels will be stronger than braces constructed using spikes.

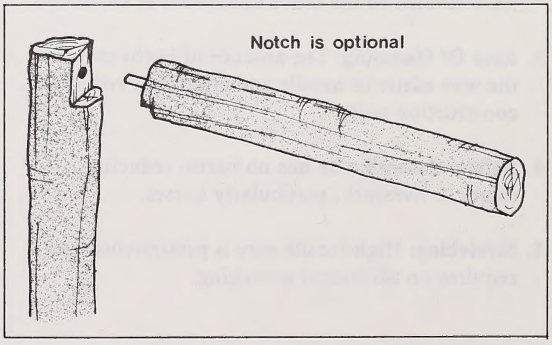


Figure 5. Dowels used to attach brace to post.

Tying off at end posts: Individual high-tensile wires can be fastened to all braces by tying off the wire with an end-post knot. This knot has only 60% of the strength of the wire.

or

Crimping sleeves can be used in tying off the wire at the end posts. Four sleeves are as strong as the wire, and are the recommended method for tying off wires.

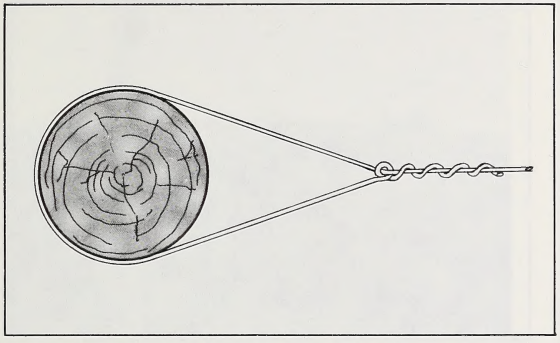


Figure 6. End post knot.

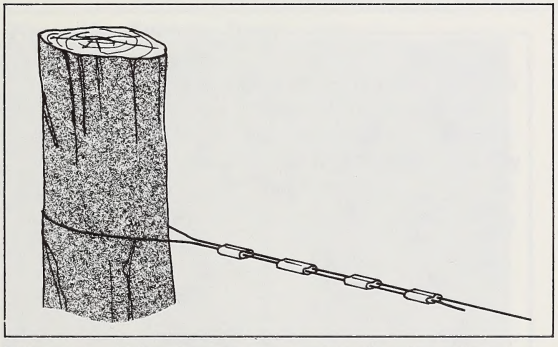


Figure 7. Crimping sleeves used to tie wire off at the end post.

In-line wire splices: A figure-eight knot can be used to tie two ends of high-tensile wire. These knots have only 75% of the strength of the wire. Crimping sleeves can be used as in-line wire splicers, 4 sleeves are required for each splice. Crimping sleeve splices are as strong as the wire, and are the recommended splicing method.

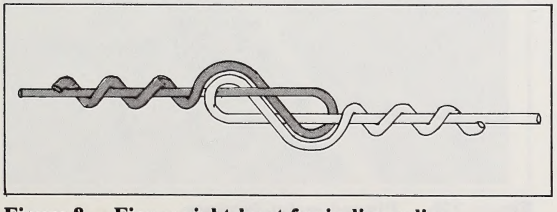


Figure 8. Figure eight-knot for in-line splice.

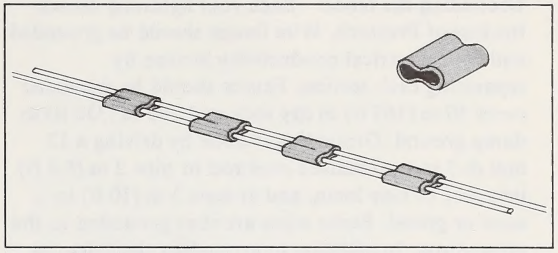


Figure 9. Crimping sleeves used for in-line splice.

In-line tension adjuster: One in-line tension adjusting device is required for each length of wire. One readily available model requires cutting the wire and uses a removable handle to wind the wire onto an automatic locking, non-slip spool. Another model is also available which does not require cutting the wire. The cost of an in-line tension adjuster is nominal.

Figure 10a. In-line tension adjuster which requires cutting the wire

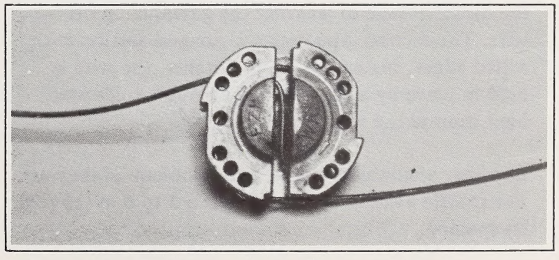


Figure 10b. In-line tension adjuster which does not require cutting the wire.

Grounding the fence: Each year lightning causes the loss of livestock. Wire fences should be grounded and their electrical conductivity broken by separating each section. Fences should be grounded every 50 m (165 ft) in dry soils and 100 m (330 ft) in damp ground. Grounding is done by driving a 12 mm (0.5 in.) galvanized steel rod or pipe 2 m (6.6 ft) into clay or clay loam, and at least 3 m (10 ft) in sand or gravel. Fence wires are then grounded to the ground rod. In addition to grounding the fence, its electrical conductivity should be broken every 500 m (1650 ft). This is done by tying the wire off at the posts.

If the fence has to be built in the close proximity of high voltage power lines special precautions need to be taken. Contact the transmission department of the utility company for special grounding instructions.

- **Droppers (stays):** One of the principal functions of a post is to maintain wire separation or spacing. This may be done at a lower cost by installing droppers which are not driven into the ground. When using droppers, spaced at 3 m (10 ft), line post spacing can be extended up to 20 m (66 ft), depending on the terrain and the kind of livestock. This significantly reduces material costs.

Conventional dropper designs tend to slide on smooth wire. Special dropper designs are used to prevent sliding. The wire is crimped as it crosses the dropper surface; this prevents the dropper sliding. Droppers can be made of wood or metal.

Wood droppers: Treated 2 x 2's with angle-cut grooves for wires are commonly used. Hardwood is preferred over softer woods. It is best to cut alternate grooves on opposing sides of the dropper so it can not slide on the wire. Alternatively, wood droppers can be stapled to the wire, though dropper sliding may be experienced.

Metal droppers: Two types of metal droppers have been developed. One is U-shaped with notches cut so the wire angles across the dropper, and the dropper will not slide on the wire. This design of dropper has the disadvantage of wearing the galvanizing off the wire. The second type uses a U shaped section with rolled edges. Instead of using notches, the wire is held in place by a pin inserted through holes and bent around the wire.

Dropper availability could be a problem. If they are not readily available, use posts at a 5 to 6 m (15 - 20 ft) spacing.

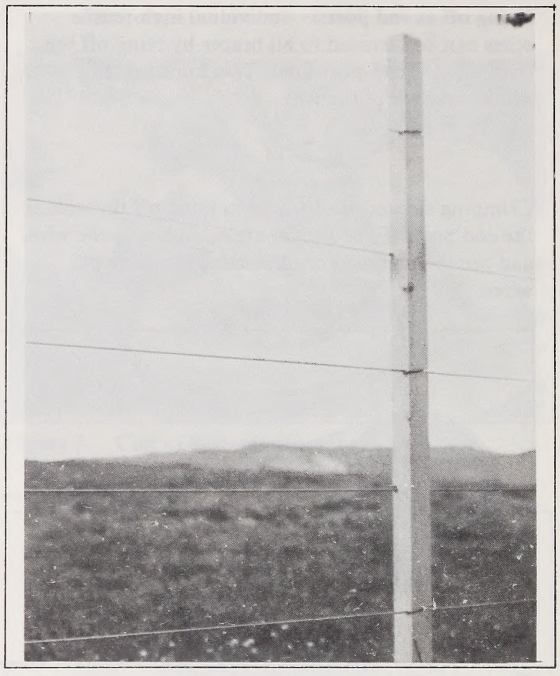


Figure 11. Wood dropper on high-tensile smooth wire fence.

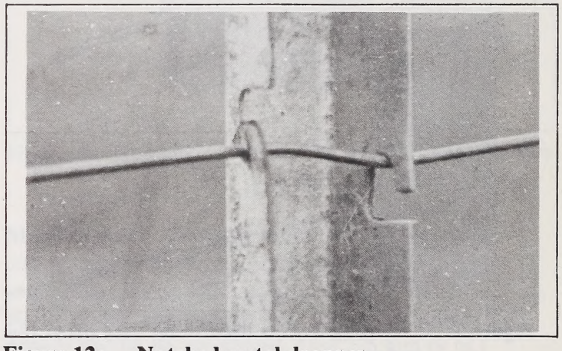


Figure 12a. Notched metal dropper.

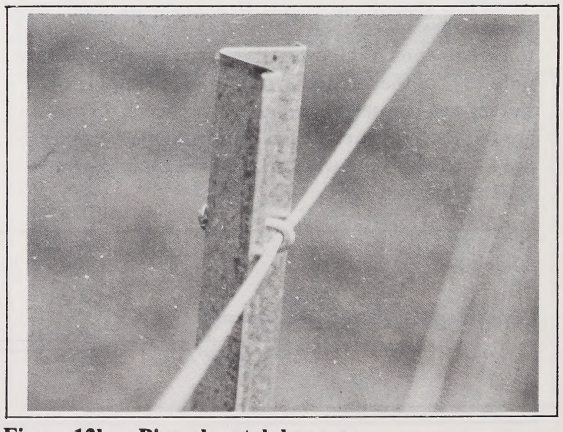


Figure 12b. Pinned metal dropper.

■ **Tools**

Like any other fencing, high-tensile wire fencing requires an assortment of tools such as hammer, fencing pliers, post driver, saw, brace and bit, etc. A crimping tool is used for in-line wire splices or fastening to endposts. A tension tester is used to measure the tension in each wire.

A "spinning jenny" is also useful for unrolling wire without entanglement. Uniform play out is important to prevent kinks which weaken the wire.

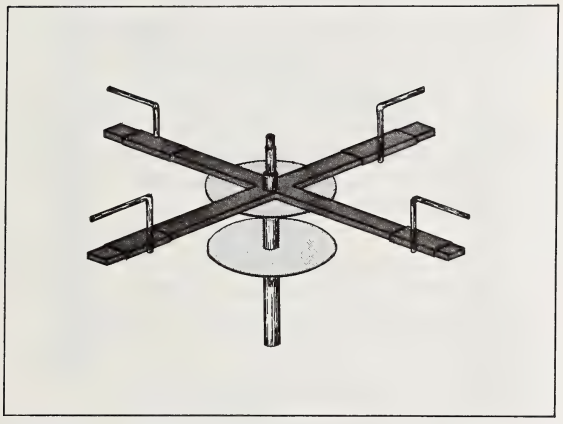


Figure 13. Spinning Jenny.

Note: High-tensile wire is stiff and has a tendency to recoil when it is cut. When cutting high-tensile wire, hold the needed end in one hand and the unneeded end down with one foot. If it is necessary to let go of the cut end, weight it down with a tool, or simply push the end several centimetres (inches) into the soil.

The lifespan of a high-tensile smooth wire fence is expected to be 30 years or longer. To ensure that the fence lasts this long it must be constructed of quality materials with top workmanship. Also, the location of the fence should be chosen so that it will fit your long term management plan. It is uneconomical to move a fence with a 30-year life after only 5 to 10 years of use.

■ **Laying Out the Fenceline**

Once the general location of the fence has been decided, walk or ride it. Pick your fence location (if possible) to avoid hazards such as steep sidehills or sloughs, and avoid corners as much as possible. By minimizing these hazards a strong fence that is easy to maintain can be constructed.

■ **Posts and Guide Wire**

The first step in fence construction is to place end, corner and gate posts. These posts serve as anchor points for stringing guide wires, and also act as part of the brace assemblies. The posts should be 150 - 200 mm x 2400 mm (6 - 8 in. x 8 ft) and set 1.25 m (50 in.) deep. Line posts are 75 - 100 mm x 1800 mm (3 - 4 in. x 6 ft) and driven 600 to 700 mm (24 in. to 26 in.) into the ground.

To set end, corner and gate posts, a smaller diameter pilot hole is augered to 900 mm (3 ft). The holes serves as a guide for pounding the post. It is augered at a slight incline so that when the post is set it will lean opposite to the pull of the wires. (top of post is about 5 mm (2 in.) off the vertical).

After all end, corner and gate posts are in place, two guide wires are strung. One is the top wire of the fence, the other the bottom wire. These wires are used to accurately place line posts on the fenceline and to maintain vertical alignment of the posts.

Once the wires have been fastened to the posts (by knots or crimping sleeves) place in-line tensioners and adjust the tension in the wires to about 0.44 kN (100 lb). Now check to see that the wires are straight. On uneven terrain, drive line posts on hilltops and at the bottom of dips to keep the wires straight and true.

■ **End Brace Assembly**

Two types of brace assembly are used: single and double span. A span length of 2400 mm (8 ft) is used for each span in a double brace but a minimum span of 3000 mm (10 ft) is preferred for a single brace. Under most fencing conditions a single span brace is preferred. Research at Kamloops has shown single braces to be as strong as most double braces. Braces are spaced as far apart as the terrain will allow, to a maximum of 500 m (1650 ft).

A double brace assembly should be used under poor soil conditions or if more than 6 wires are used. The two boxes making up the double brace must be perfectly in line with each other, as well as being in-line with the fence. If they are not lined up, the strength is less than that of a single brace.

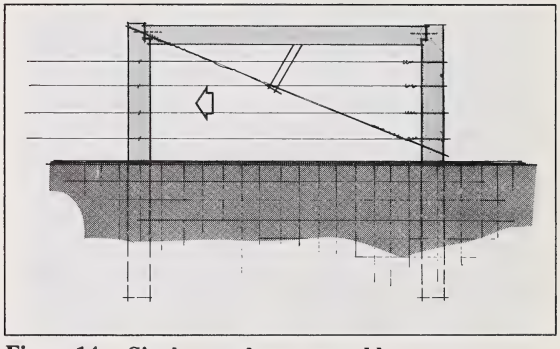


Figure 14. Single span brace assembly.

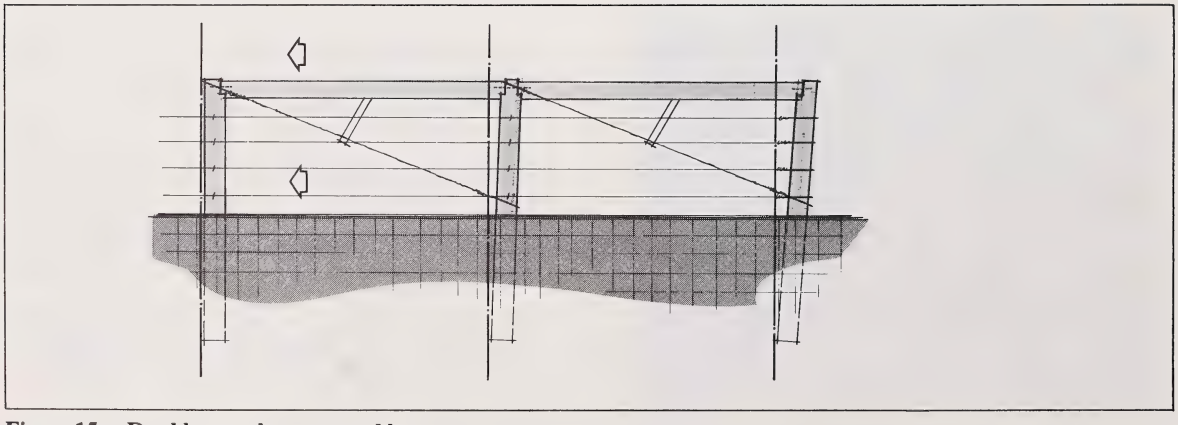


Figure 15. Double span brace assembly.

The horizontal brace for both a single and double span-type is pegged into place using 10 mm (⅜ in.) rods. The rods are driven through a hole in the side of the post 75 - 100 mm (3 - 4 in.) from the top and into a hole drilled in the end of the horizontal brace. The holes should be slightly smaller in diameter than the rod. Shallow notching of the post to accept the horizontal brace can also be used. Leave 25 to 50 mm (1 to 2 in.) of the pin exposed to hold the brace wires in place.

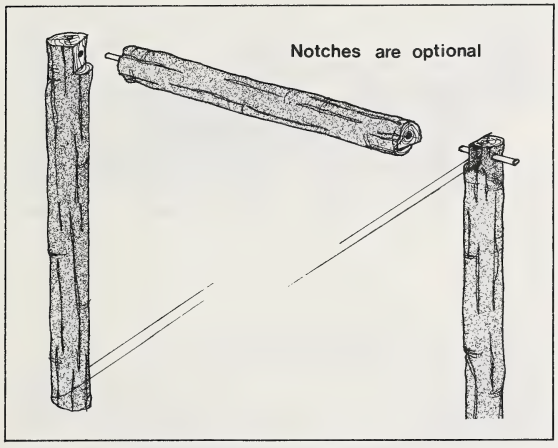


Figure 16. Notched and pinned brace.

Once the posts and horizontal brace are in position, the brace wire can be attached. Drive a staple half way into the post, 100 mm (4 in.) from the ground at the back of the end post. Two wraps of wire are placed under the staple on the end post and over the pin stub on the other brace post and tied off. A pressure-treated twitch stake is used to adjust tension in the wires. It is locked behind the horizontal brace so that it will not unwind. Or the tension can be adjusted in the brace wires with a temporary smooth wire tension adjuster, then crimped. Figure 17 demonstrates the construction of an end brace.

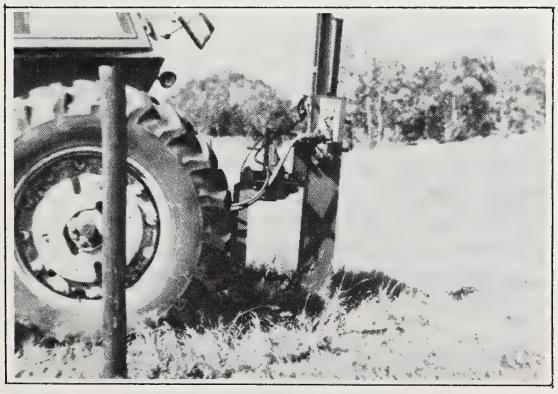


Figure 17a. Brace posts after driving.

Figure 17b. Drilling the holes for the pin.

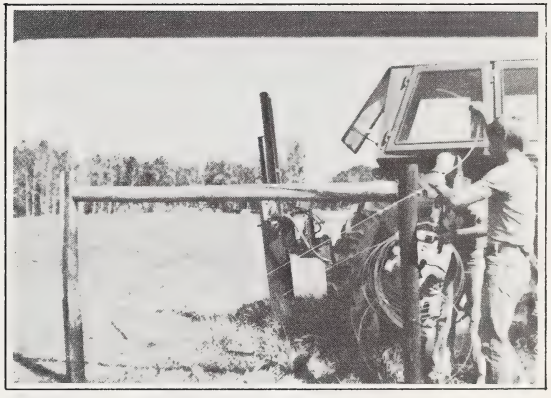


Figure 17c. Wrapping the base wire.

Figure 17d. Finished brace assembly.

■ **In-Line Brace**

A single span end brace assembly should be used for all in-line braces. A second brace wire forms an X with the first wire. Fence wires must continue to the far side of the brace assembly so that the forces are distributed across the brace.

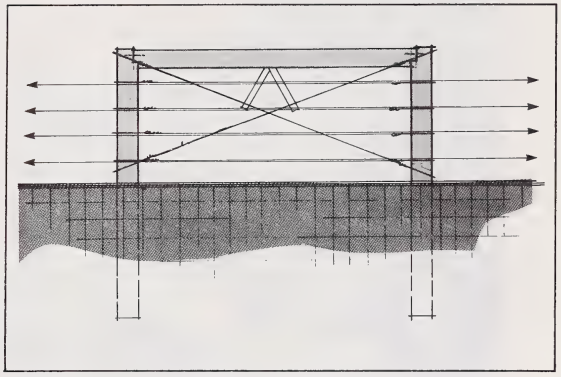


Figure 18. Construction of in-line brace assembly.

■ **Corner Assemblies**

Keep the number of angles in the fence to a minimum. Figure 19a shows a good corner brace. However, it is possible to fence around gentle curves without constructing corner brace assemblies, as shown in Figure 19b.

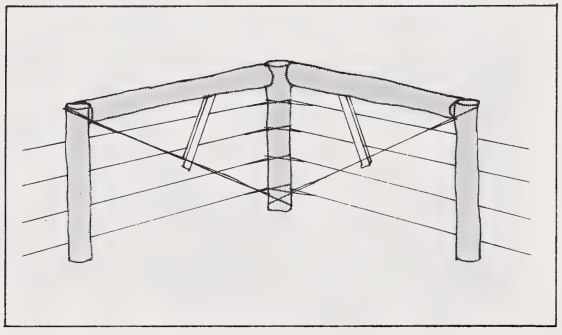


Figure 19a. Corner brace assembly.

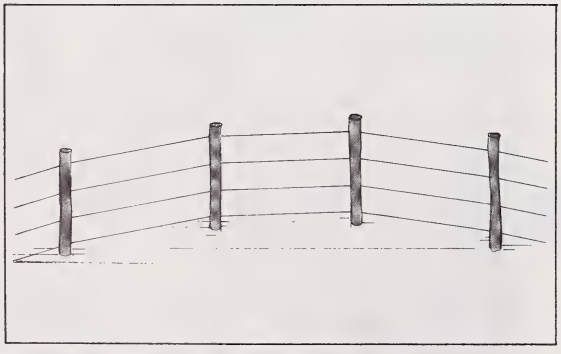


Figure 19b. Fencing a gentle curve without using corner brace assembly

■ **Bracing On A Changing Slope**

A double in-line brace assembly should be constructed where there is a major change in slope. The centre post of the assembly is located at the break in the slope. Each half of the assembly is then constructed on its respective slope. Wires from both directions are tied off at the centre post of the brace assembly.

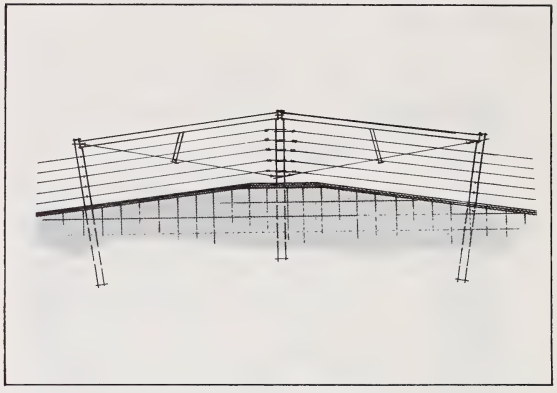


Figure 20a. Bracing at the top of a rise.

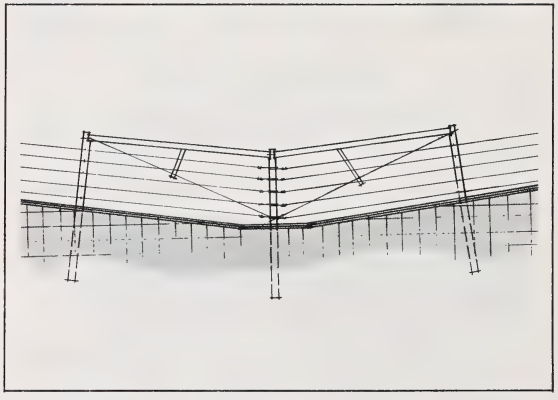


Figure 20b. Bracing at the bottom of a dip.

■ **Driving the Line Posts**

The two guide wires are used to set the posts straight and vertical.

When fencing up and down slopes, posts should be driven perpendicular to the surface of the ground. Not following this procedure will reduce the height of the fence. Note, in Figure 21b that post placement is perpendicular to the ground surface.

Wire should be located between the posts and the greatest livestock pressure. On sloping terrain, the wire is on the uphill side of the post.

Line posts are usually spaced 5 to 6 m (15 to 20 ft). By using one or more droppers, post spacing may be up to 20 m (66 ft).

■ **Fencing Through Dips or Gullies**

For small dips or gullies take the main fence straight across; posts are driven in the dip. Extra wire is used to form a V between the main line posts and the posts in the dip.

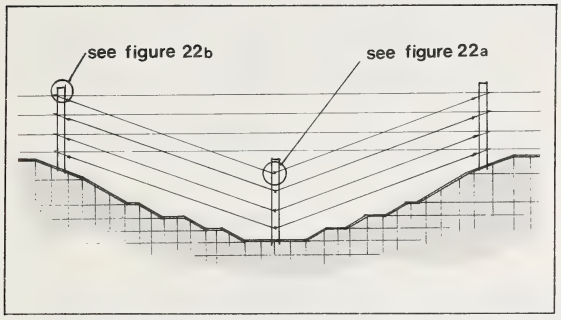


Figure 21a. Fencing across a small gully.

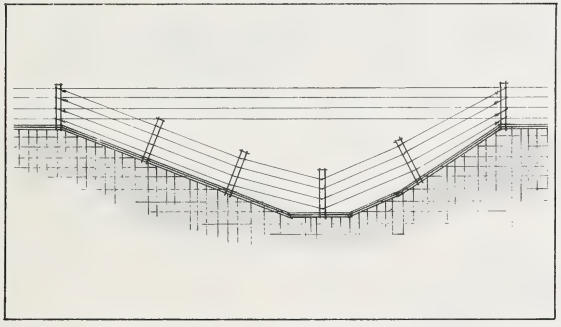


Figure 21b. Fencing through a larger gully.

■ **Wire Spacing**

The number of wires and the spacing between the wires will depend on the kind of livestock. Normally you can replace standard barbed wire strand for strand—areas now using 4-strand barbed wire can use 4-strand high-tensile smooth wire.

Table 1 gives application and wire spacings for high-tensile smooth wire fences.

■ **Stapling**

Before stapling, adjust tension in each wire to 0.44 kN (100 lb) tension. This is to prevent the wires crossing and being stapled at wrong levels on the posts.

Staples should never be driven all the way "home" into the post. Doing so results in a less effective fence; the resistance from the staples does not allow the wire to behave elastically along its full length. It can also kink the wire, making it weaker.

Use 50 mm (2 in.) or longer staples because 45 mm (1 ¾ in.) staples are too short to allow proper wire clearance. Always rotate the staple so that the slash cut forces the legs to spread in the post, increasing holding power.

To counteract the pull of the wire in dips and on hills, drive staples at an upward angle into dip posts and at a downward angle into hill posts. On very steep rises or dips, driving two staples in either of the ways shown in Figure 22 helps to hold the wires against the posts and is a good insurance against pullout.

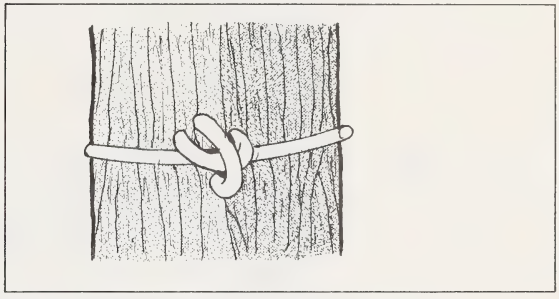


Figure 22a. Staple installation on a dip post.

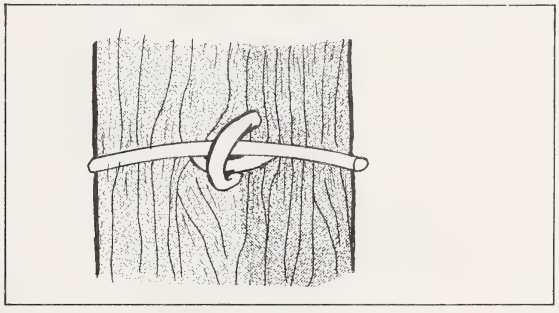


Figure 22b. Staple installation on a rise post.

Friction between the wire and the posts on gentle curves can be reduced by placing staples between the wire and the posts. This can be accomplished by stapling as shown in Figure 23.

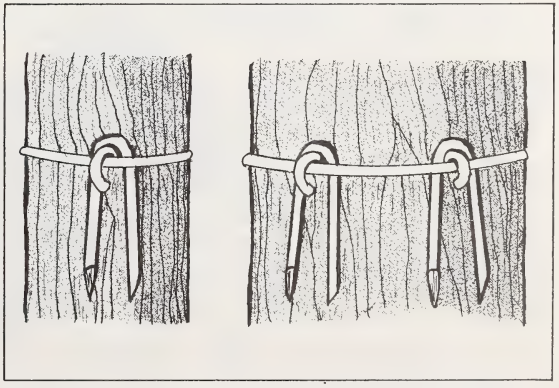


Figure 23. Staple placement to support wire around end or corner posts.

TABLE 1. HIGH-TENSILE SMOOTH WIRE FENCE APPLICATIONS AND WIRE SPACINGS

NUMBER OF STRANDS	APPLICATION	HEIGHT FROM GROUND mm (inches)	WIRE SPACING (from ground up) mm (inches)
4	Replaces 3 and 4	1010 (40)	380 (15), 200 (8), 200 (8), 230 (9)
4	(pasture and range fencing	1160 (46)	380 (15), 250 (10), 250 (10), 280 (11)
5	Designed for moderate to heavy grazing by large animals (horses, etc.)	1140 (45)	400 (16), 180 (7), 180 (7), 180 (7), 200 (8)
6	and for longer post spacing [12 m or more (40 feet or more)]	1160 (46)	330 (13), 150 (6), 150 (6), 150 (6), 180 (7), 200 (8)
8	Contains small and large animals discourages some wildlife and dogs, and longer post spacings	1170 (46)	100 (4), 130 (5), 130 (5), 130 (5), 150 (6), 150 (6), 180 (7), 200 (8)
*10	Replaces woven wire, will contain most kinds of livestock, turns away dogs and wildlife; discourages predators if 2nd, 4th and top wires are electrified	1180 (46)	100 (4), 100 (4), 100 (4), 100 (4), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5)
10	feedlot fence	1330 (52)	250 (10), 100 (4), 100 (4), 100 (4), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5)
12	horse fencing	1460 (57)	100 (4), 100 (4), 100 (4), 100 (4), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 150 (6)

**Note:* posts are drilled for this wire, or staggered on alternate sides of this wire.

■ **Placing the In-Line Tension Adjuster**

In-line tension adjusters should be installed at the mid-point between braces. This makes it easier to adjust the tension in the fence. However, the tensioner should not be installed immediately next to changes in slope, nor between any two posts within a corner or a curve. On fences less than 200 m (660 ft) long tensioners can be installed at either end of the fence, or near a gate for easy accessibility.

As a general guide use one in-line wire tension adjuster per strand for every 500 m (1650 ft). If the terrain is very rough this distance will be reduced. Fences which contain several corners or curves or rises and dips may require two or more tension adjusters per wire.

Wire tension should be adjusted in stages of 0.44 kN (100 lb) to a maximum tension of 1.10 - 1.3 kN (250 - 300 lb). Work from the top wire downwards for easier separation of the wires and to provide clearance for turning the handle. The in-line tension adjuster also permits seasonal adjustment of wire tension to compensate for temperature change. During the winter, tension on the wires should be reduced or a spring assembly should be used. A spring assembly is shown in Figure 24.

TABLE 2. WIRE TENSIONS FOR SEVERAL TEMPERATURES

Temperatures	Tension
-10° C	1.55 kN (350 lb)
0° C	1.33 kN (300 lb)
10° C	1.22 kN (275 lb)
20° C	1.11 kN (250 lb)

It is possible to measure the approximate tension on any particular stand anywhere on the fenceline by means of a simple device which you can make at low cost. Figure 25 shows a homemade wire tension tester. Take a piece of wood 1100 mm (42 in.) long and place nails 1016 mm (40 in.) apart. Use a spring scale that will measure up to 10 kg (22 lb), and pull the wire with the spring scale to deflect the wire 12.7 mm (0.5 in.). Read the scale and multiply the scale reading to obtain the tension. If reading in pounds, multiply by 20 for pounds of wire tension, or by 0.09 to get kN of wire tension. If the reading is in kg, multiply by 0.20 to get kN of wire tension.

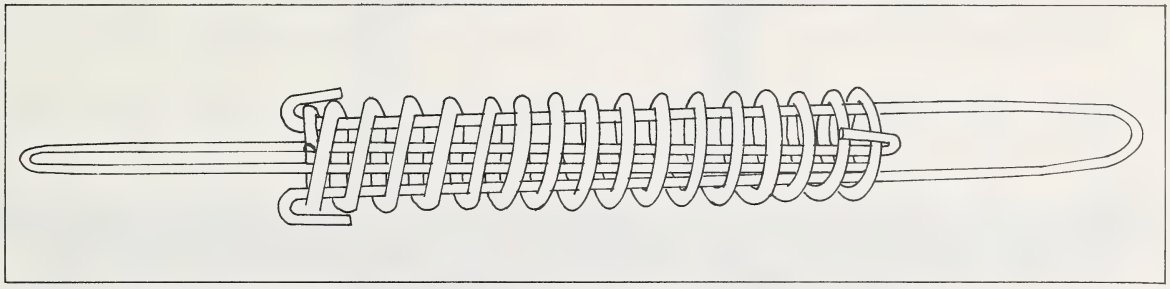


Figure 24. Tension spring assembly

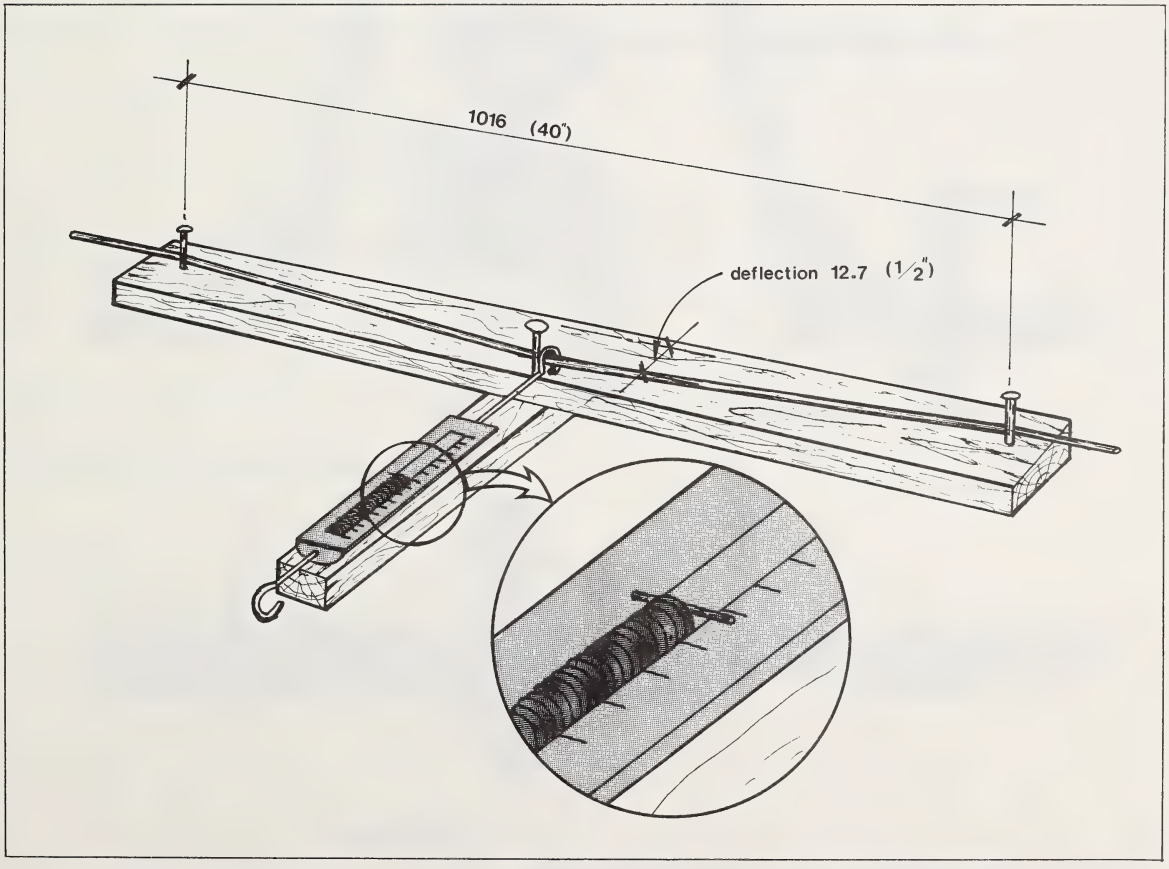


Figure 25. Wire tension meter.

Gate Types and Location

When locating and installing livestock and machinery gates in high-tensile smooth wire fences, use the same considerations that apply to gates in other types of fences. Such gates should be (1) located for maximum convenience and efficiency in farm management, (2) at least as high as the fence, (3) wide enough to permit passage of the widest piece of machinery, (4) level enough and hinged on the proper side to swing freely, and (5) durable enough to last as long as the fence.

There are a variety of styles and sizes of prefabricated gates available and they are usually excellent for use in high-tensile smooth wire fences. Gates can also be fabricated on site at a lower cost with pressure-treated lumber or steel pipe with wires as shown in Figure 27. For gates that you frequently drive through, a "Texas gate" (cattle guard) can also be installed. Basically a "Texas gate" (cattle guard) is made by spacing a pipe grate over a dip in such manner that the livestock can not walk over it but cars and farm machinery can. CPS Plan M8362 shows the details of a "Texas gate", and is available from Alberta Agriculture.

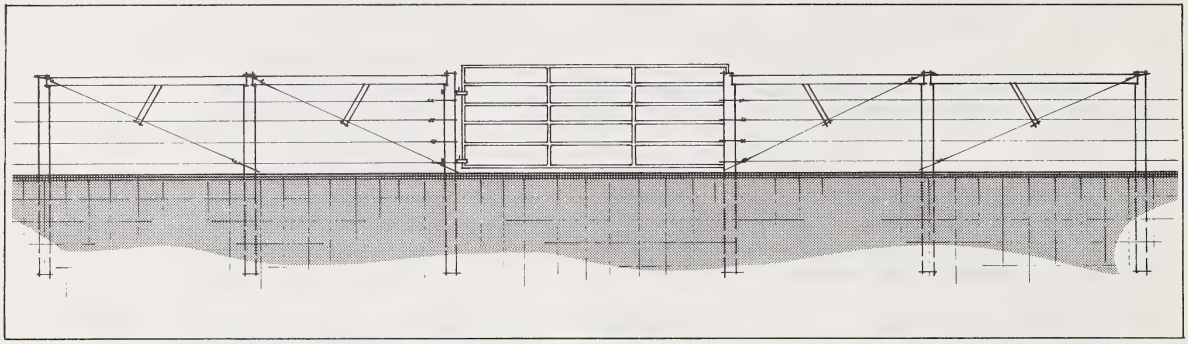


Figure 26. Conventional gate in high-tensile smooth wire fence.

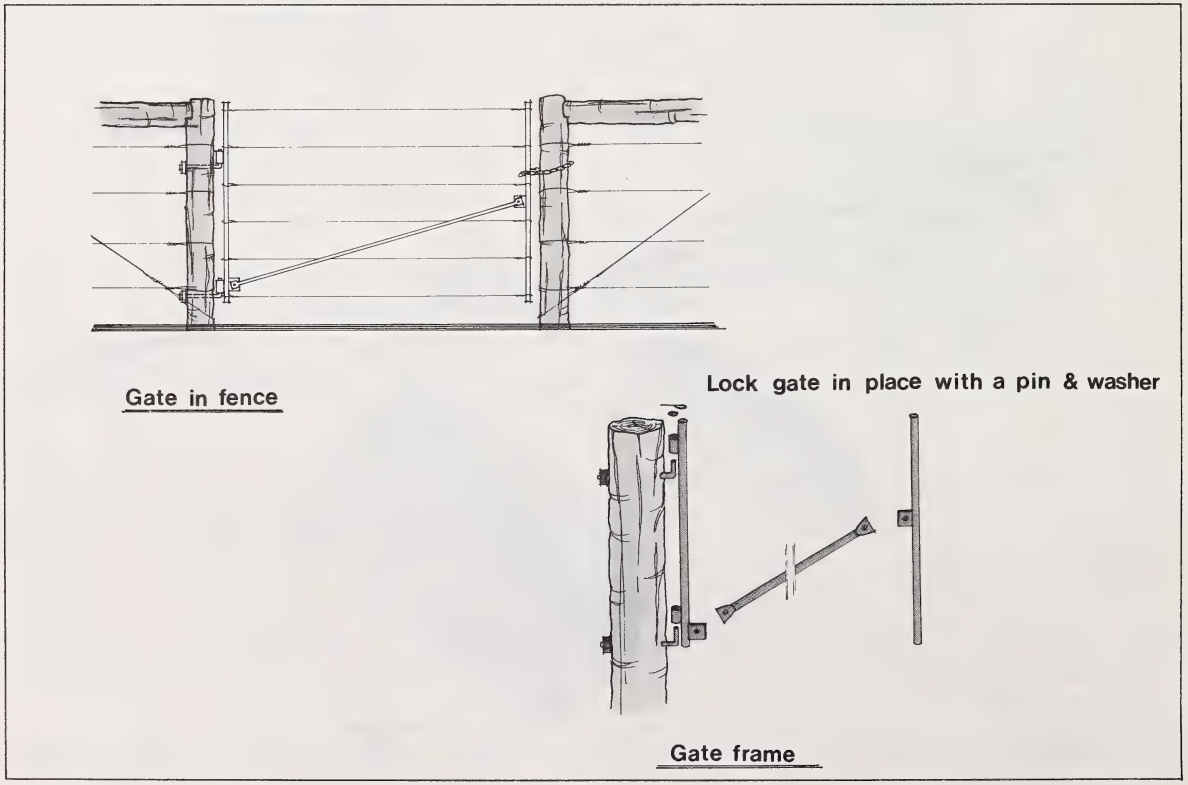


Figure 27. Light weight gate in high-tensile smooth wire fence.

In boundary fences near busy roadways, it may be necessary to set gates back from the fenceline to permit pulling long farm implements off the roadway. In such instances, it is more practical to build a plank fence on the sides of the offset than to erect two short sections of high-tensile wire fence.

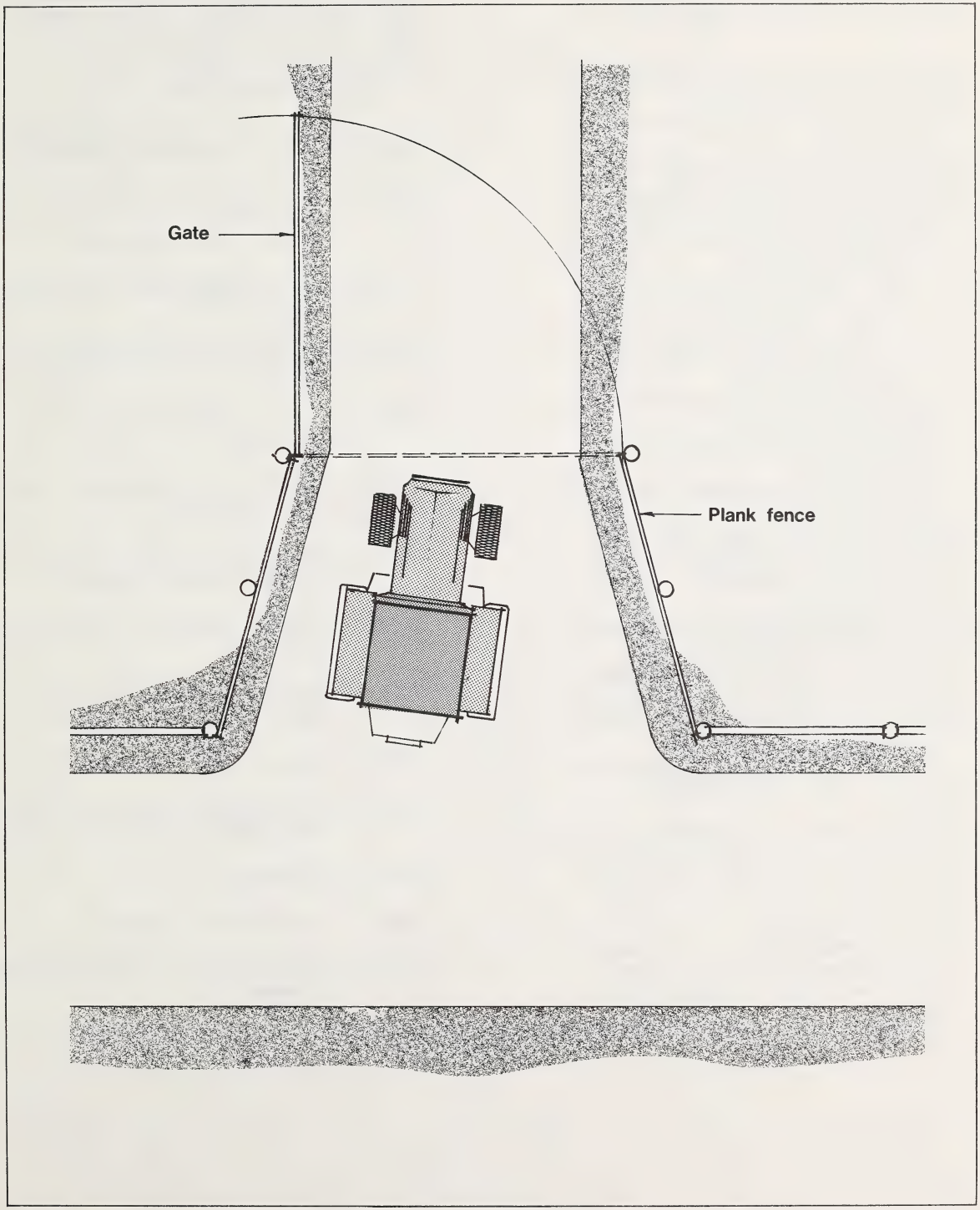


Figure 28. Offset gate.

PART IV SAFE FENCING PRACTICES

Anyone building a wire fence is subject to cuts and scratches from the wire. Chance of injury will be reduced by observing the following safety precautions:

- Wear tightly woven, tough clothing that will not catch on the ends of the wire.
- Wear heavy-duty, gauntlet-type leather gloves which fit snugly.
- Wear long pants and high work shoes with heavy soles to protect the feet and legs.
- Have the right tool for each job, keep it in good condition and use it only according to manufacturer's directions.
- Wear safety goggles or eye shields when cutting the wire or adjusting the tension of the wire, as well as when driving nails or staples.
- Never carry nails or staples in pants pockets. Use a nail apron or tool bag.
- Use driving caps on posts as recommended by the post driver manufacturer.
- Keep children and livestock away from all fencing operations.
- When handling, driving, drilling, nailing or stapling chemically treated wood posts or lumber, wear face shields and rubber gloves, and cover otherwise unprotected areas of your skin. Some people are allergic to wood-preserving chemicals.
- Never use unsafe shortcuts, or eliminate such items as safety wires on twitch sticks.
- Pick up all cut ends of wire, dropped staples and nails, etc., so they will not cause injury to humans, be eaten by grazing livestock,damage mower blades, or snarl equipment.
- Don't work at fencing during electrical storms.
- Properly ground the fence as soon as it is erected.
- Remember, wire is an excellent conductor. Be careful when stringing the guide wire or line wires that they do not come in contact with any powerlines overhead or at ground level where you are working.
- Be cautious when driving posts in the vicinity of buried gaslines, electrical lines or other utilities (most utilities will locate and mark buried services).

PART V SUMMARY

High-tensile smooth wire fencing has proven to be a less expensive alternative to traditional fencing methods. Quality materials and good workmanship produce a strong, long-lasting fence. The absence of barbs produces a fence that does not damage livestock hides or injure humans.

APPENDIX I: Construction Procedure

STEP 1: Walk or ride potential fence route. Choose fence location to avoid or minimize steep sidehills, sloughs and corners.

STEP 2: Clear fenceline, levelling as many dips and hills as possible.

STEP 3: Place end posts for all brace assemblies on fenceline.

STEP 4: String top and bottom wires to act as guide wires.

STEP 5: Insert in-line wire tension devices and adjust wires until taut.

STEP 6: Using guide wires to ensure straightness, construct all brace assemblies.

STEP 7: Adjust the tension of the guide wire to 0.44 kN (100 lb).

STEP 8: Use guide wires to drive line posts to ensure they are vertical and in line.

STEP 9: Staple wire to line posts and braces.

STEP 10: Working from the top wire down, adjust wire tension to 1.11 kN (250 lb) in stages.

STEP 11: Ground fence.

STEP 12: Insert droppers as required.

STEP 13: After a few days return and adjust tension on wires.

REFERENCES

1. HOW TO BUILD FENCES WITH MAX-TEN 200 HIGH-TENSILE FENCE WIRE
   United States Steel

2. HIGH TENSION HIGH-TENSILE FENCING
   Quinton, D.A.
   Research Branch
   Agriculture Canada
   Kamloops, BC

3. ASAE Yearbook, 1981

4. CSA Code B72 - Installation of Lightning Rods

5. HIGH-TENSILE SMOOTH WIRE FENCING
   BC Ministry of Agriculture
   and Food